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Best Architectural Coloring Practices for Concrete

Prepared for
WHRP Structures Technical Oversight Committee

Prepared by
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WisDOT Research & Library Unit

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Keywords: concrete, color architectural concrete, aesthetic.

Summary

We found 14 citations for documents published in 2001 or later. Four of the 14 citations were published in 2008, one in 2007, two in 2004, four in 2003, two in 2002, and one in 2001. Five of these citations refer to research on aesthetic enhancement of structural concrete, and nine citations refer to research on aesthetic enhancement of concrete in general.

Structural Concrete

Citations

Links to online copies of cited literature are provided when available. Contact the WisDOT Library to obtain hard copies of citations.

Title: Sensibility Evaluation to Colored Architectural Concrete Using Sand and Pigments
Author(s): Liu, Lingzhi; Masuda, Yoshihiro; Konishi, Toshimasa; Sakaki, Tomoya
Date: August 2008
Source/URL: *Journal of Structural and Construction Engineering*, Vol. 73, No. 630, pages 1233-1238.
Description: 6 pages
Contents: Architectural concrete in Japan has been valuated from the viewpoint on design in the foreign countries, because the texture of the concrete using painting form is smooth liking a mirror and lucid, and the image is stern. However in the present circumstances, there were extremely few reports on quantitative analysis of the influence of the surface properties on the image of colored architectural concrete. In this study, as a basic examination, the concrete test pieces were made by using color sand and pigments. The influence on the gloss and the color of concrete was experimentally examined using materials and forms. And using those test pieces, the image tests were carried out. The influence on the image of colored architectural concrete was experimentally examined using the surface properties of concrete. According to the result, the correlation between the surface properties of colored architectural concrete and the materials was clarified, the images of colored architectural concrete were extracted, and the relation between the surface properties and the image was quantified.

Title: Methodology for Aesthetic Repair and Rehabilitation of Architectural Concrete
Author(s): Zhang, Yu
Date: May 2008
Source/URL: Thesis/dissertation, University of Johannesburg, Department of Civil Engineering Science, http://hdl.handle.net/10210/472.
Description: N/A
Contents: Structural concrete can be treated using a variety of special methods to produce aesthetically pleasing effects. This type of concrete is called architectural concrete. It is possible to produce structures with colourful, smooth or textured surface finishes that will satisfy any of the demands of modern architecture. It is clear that matching the colour and texture of repair work in architectural concrete is problematic. Concrete surfaces with different types of finishes require different rehabilitation processes, just as different ages of concrete require different repair methods. The concrete life cycle is set up for aesthetic repair in this research. Before a repair project is undertaken it is important to ascertain the type of failure. The causes of the failure should be identified and removed if possible. The factors influencing the appearance of the concrete surface should be discussed, in order that the right skills and technical methods are employed during the rehabilitation process. The repair method should be divided into two categories, one is for the young concrete, and another is for the old concrete. A good starting point for the patching mortar of both young and old architectural concrete are suggested as a result of the experiments. Two new factors have been established as a result of this research, namely the colour coefficient and the colour influence coefficient, both of which will be beneficial to future research projects.

Title: Stone-Crete—Bridge Aesthetics
Author(s): Hass, Irina; Cofoid, Rich; Lowe, Michael; Lowe, Michael Jr.; Lowe, Mark
Date: May 2004
Source/URL: Paper from The 2004 Concrete Bridge Conference.
Description: 13 pages; CD-ROM
Contents: This paper describes how Stone-Crete is one of the tools that make concrete bridges not only an element of transportation, but also a complete marriage of aesthetics and durability. The high cost of labor and material has made the use of genuine stone or rock in construction prohibitively expensive. As a result, relatively inexpensive polymers and concrete have become popular in the manufacture of artificial stones and rocks. However, the production of aesthetically appealing artificial stone is difficult, specifically related to the replication of real stone texture and color. Stone-Crete is an architectural concrete system that creates deep relief stones with a variety of available textures and colors. It is a system that produces a surface of cementitious material including a plurality of surface areas each produced by a form liner to simulate the appearance of natural stone or rock. The construction process involves, but is not limited to, attaching the Stone-Crete liners to forms. The liners are then set for a normal concrete wall pour and concrete is then poured between forms (either plain or integrally colored concrete can be used). Next, forms are stripped away and a final coloring process is applied to the concrete to produce a look of natural stone.

Title: Colored Concrete Bridges: Construction and Life-Cycle Cost
Author(s): Chusid, M.; Strockbine, E.; Paris, N.
Date: June 2003
Source/URL: *Concrete International,* Vol. 25, No. 6, pages 76-81.
Description: 6 pages
Contents: This paper describes a construction and life-cycle cost study comparing the use of surface-applied finishes to integral colors for a hypothetical cast-in-place bridge. Construction cost models were developed based on a national 20 U.S. city average of construction costs, with only those elements of the bridge affected by the choice of coloring systems included. Initial construction cost estimates show a potential 2.5 percent savings in construction costs using colored concrete rather than surface coatings. The life-cycle analysis assumed a 25-year service life for the coating system and the need to reapply the coating three times during the 100-year life of the bridge. The study also assumed the colored concrete bridge would be cleaned once during the bridge's service life. Given these assumptions, a comparison of life-cycle costs shows a potential 17 percent life-cycle cost savings with the use of integral colors. Additional cost efficiencies are possible if the structure is designed to maximize the advantages of integral color or if the contractor chooses to use uncolored concrete at locations that are not exposed to view. A comparison of initial and life-cycle costs for coatings versus colored concrete by structural element also is provided. For most structural elements, colored concrete is the most cost-efficient option.

Title: Creating a World of Colorful Concrete Opportunities
Author(s): Shydlowski, L. M.
Date: June 2003
Source/URL: *Concrete International*, Vol. 25, No. 6, pages 46-49.
Description: 4 pages
Contents: An initiative was launched in 1993 to stimulate growth in the once-stagnant ready-mixed concrete market. Value-added concrete products that provide color and texture have been developed to make concrete a more aesthetically pleasing building material. New technology and production efficiencies make it possible to replicate the appearance of materials such as brick, slate, and granite while providing greater durability, a longer service life, and often a significantly lower price than these other materials. However, producing and placing high-quality colored architectural concrete requires the use of a full system of compatible materials. New admixtures have been developed specifically for use in ready-mixed and precast concrete applications for producing structurally sound and durable concrete. Next generation batching apparatus for liquid color addition can improve the consistency and accuracy of color formulations. Skilled contractors, with training in achieving unique finishes and in the correct use of compatible color-matched compounds and sealers, also are an integral part of the architectural concrete industry. Market demand for these products seems to be growing, with production volume of integrally colored concrete expected to increase at a rate of over 15 percent per year.

General Concrete

Citations

Title: A New Look with Decorative Concrete
Author(s): James Informational Media, Incorporated
Date: August 2008
Source/URL: *Better Roads*, Vol. 78, No. 8, pages 42-44.
Description: 3 pages
Contents: This article presents a special feature on decorative concrete, which includes colored and stamped pavement sections. As cities spruce up their downtown areas, the technique is gaining in popularity. In Michigan alone, there are 30 to 40 recent examples. Recent award-winning projects are described, such as the one in Reno, Nevada, which involved the complete reconstruction of a major thoroughfare, Virginia Street. It is one of four downtown projects to be built with concrete. Details of the coloring techniques best-suited to different environments are given. Additionally, a trade association-approved list of recommended additives to achieve various hues is given. A “referee sample” of the projected color is recommended prior to awarding a bid to ensure consistency between projected and actual color in the finished product.

Title: Creating Colorful Concrete: How to Design for Durability and Aesthetics
Author(s): Jancy, Howard
Date: 2008
Source/URL: *The Construction Specifier*, Vol. 61, No.3.
Description: N/A
Contents: As concrete has evolved into a decorative construction material that can be colored, patterned, and shaped, simply specifying decorative concrete based only on engineered principles may yield less than aesthetic results. This article compares the various coloring products for decorative concrete flatwork and highlights specific decorative concrete mixing, handling, and finishing techniques for quality installation. Adjustments to standard concrete specifications are also discussed.

Title: Getting Creative with Concrete Pavement: Colors and Stamped Designs Improve Aesthetic Value
Author(s): Jackson, Sheryl S.
Date: 2007
Source/URL: *Surface Transportation*, Vol. 3, No. 4, pages 10-12.
Description: 3 pages
Contents: Area replacement or revitalization is driving the trend of using colored and stamped concrete pavements. Stakeholders, including planners, are finding that decorative concrete techniques, including coloring, etching, staining, and stamping, add charm, personality and vibrancy to virtually any area. Examples of colored and stamped concrete pavement use included in the article are the University of Wisconsin–Madison; Overland Park, Kansas; New Castle, Pennsylvania; and Fort Wayne, Indiana. An insert provides information on websites with additional information on architectural or decorative concrete techniques.

Title: Incorporating Colored Crosswalks in Concrete Pavements
Author(s): American Concrete Pavement Association
Date: March 2004
Source/URL: *R & T Update—Concrete Pavement Research & Technology.*
Description: 4 pages
Contents: To enhance the appearance of a concrete surface, many colors and textures of stamped and/or colored concrete are available, often providing a low-cost simulation of natural stone, brick, or other material. The use of decorative concrete is often seen for urban streetscape programs meant to revitalize downtown areas, or as an effective way to alert pedestrians and motorists of crossings as a safety measure. The paper provides basic information on the technique of coloring process, formulas for colors, coloring materials, and design and construction.

Title: Coloring Ready-Mixed Concrete
Author(s): Chusid, M.
Date: December 2003
Source/URL: *Concrete International,* Vol. 25, No. 12, pages 92-93.
Description: 2 pages
Contents: Automated coloring systems for ready-mixed concrete rely on computer technology to control the metering and dispensing of liquid colorants. This article describes one such system that uses a standard personal computer operating system and user interface to allow the operator to select a standard color from a drop-down menu or to mix, match, and preview custom colors. The system connects to the Internet, linking a concrete producer with its color supplier. A related system has been designed that provides a connection between concrete producers and concrete end-users. With this system, designers and builders can select from one of over 17,000 different colors. Color selection can be adjusted for hue and dosage rate. Custom-colored samples can be ordered via email before final selection.

Title: Glass Concrete
Author(s): Meyer, C.
Date: June 2003
Source/URL: *Concrete International,* Vol. 25, No. 6, pages 55-58.
Description: 4 pages
Contents: Using recycled waste glass as concrete aggregate offers promise as a way to reduce solid waste while increasing the strength, durability, and aesthetic appearance of concrete products. Harmful expansion can occur when alkali in the cement paste reacts with the silica in the glass, but technical research has led to ways to suppress the detrimental effects of alkali-silica reaction. Although the economic benefit of substituting glass for fine aggregate is marginal, the use of glass does offer other benefits. Glass is durable, abrasion resistant, improves the flow properties of fresh concrete so that very high strengths can be obtained and can serve both as partial cement replacement and filler. If glass is sorted by color and this color is coordinated with the cement matrix, interesting aesthetic effects can be achieved. Glass also can replace more costly materials such as marble. By adding value to a waste product, both the waste management and concrete industries stand to benefit financially. However, industry and academia must cooperate in order to develop marketable glass concrete products.

Title: Designing with Colored Architectural Concrete
Author(s): Ball, J. C.; Decandia, M.
Date: June 2002
Source/URL: *Concrete International,* Vol. 24, No. 6, pages 22-26.
Description: 5 pages
Contents: Colored concrete is increasingly being used for a variety of building and renovation projects. Colored and textured architectural concrete can mimic other surfaces such as brick, tile, granite, wood, slate, and limestone, and offers long-term value at a lower cost. This paper discusses some of the issues and challenges in designing with colored concrete. Materials and methods, factors affecting color, effect of worker skill, and curing and sealing are discussed. When planning a colored concrete project, designers should work with color admixture manufacturers to choose the most appropriate product. The concrete producer, contractor, and owner should also be included in the process to make sure all members of the team understand and agree on the expected outcome. A full-scale job site mockup is recommended as the standard used in approving color, finishing techniques, and final appearance of the job.

Title: Decorative Concrete has Come a Long Way!
Author(s): Boyer, L. A.
Date: June 2002
Source/URL: *Concrete International*, Vol. 24, No. 6, pages 62-67.
Description: 6 pages
Contents: The design community is increasingly incorporating decorative concrete in both the interiors and exteriors of new and existing projects. As design professionals become more familiar with specifying decorative concrete, the industry will continue to grow. This article provides an overview of the materials used to produce decorative concrete and their characteristics in achieving color and texture. The materials reviewed include color hardeners, integral color, chemical stain, stamped concrete, cast-in-place wall caps, decorative sawcutting, cast-in-place walls, template sandblasting, and exposed aggregate finishes.

Title: Colored Concrete: Aesthetic Value and More
Author(s): Paris, N.; Chusid, M.
Date: February 2001
Source/URL: *Civil Engineering News*, Vol. 13, No. 1, pages 51-55.
Description: 5 pages
Contents: One property of concrete is often overlooked—color. Preoccupied by concerns about compressive strength and other structural criteria, many engineers are not even aware that concrete can have color. Concrete can be produced in a wide spectrum of shades by adding color pigment to the mix. Color can make concrete even more valuable to solve civil engineering problems such as safety, maintenance, and environmental impact. Colored concrete can be used to enhance the visibility of median strips in roadways and to mark crosswalks at intersections. It can also be used to mark the location of curb ramps in sidewalks and to create a safety zone at the edge of train station platforms. Black-colored concrete absorbs more solar radiation than untinted concrete and is useful to help control ice formation on airport aprons. This article provides a thorough overview of the utility and aesthetics of colored concrete in highway and structural construction.